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Measurement and simulation of the mass and energy balance of Hintereisferner, Ötztal Alps, Austria

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We investigate the energy and mass balance of Hintereisferner (Ötztal, Austria), which is one of the Alpine benchmark glaciers.

This is based on measurements at two representative sites in the ablation and accumulation area of the glacier. For the first time, the year round local glaciological and meteorological features are documented in full detail, thus addressing aspects of the spatial distribution and the interrelationship between the energy and mass balance and their potential climate sensitivity. Partly, these measurements also served as input for a numerical mass-balance model (SOMARS) to compute the surface and subsurface processes in response to the atmospheric forcing. The simulations are verified by independent meteorological and glaciological data from different sources.

At the end of winter, the lower measurement site (2640m a.s.l.) experienced 2.2m of snow accumulation as compared to 3.3m at the upper site (3048m a.s.l.). During summer, there is about twice as much melt at the lower site on the other hand. The energy fluxes are generally small during winter and net short-wave radiation is the dominant energy flux at both locations. This is most pronounced during summer and at the tongue of the glacier, where about 63% of the melt energy was provided by absorbed solar energy. At the upper measurement site, where the snow cover lasted 67days longer, the albedo remained comparatively high and solar radiation input was about half on average. The sensible heat fluxes continuously provided energy to the surface, which at the lower site makes 34% of melt energy and 41% at the upper site, respectively. The latent heat fluxes were comparatively small and of opposite sign to the sensible heat fluxes. Notably however, there is prevailing condensation during July

and August, which thus enhances melt. At both stations the calculated mass balance agrees well with the directly measured data. This gives confidence in the method used, which is further verified by comparison of the model results with additional data like surface and snow temperatures or snow pit measurements.

Based on these locally calibrated simulations, the spatial distribution of the energy and mass balance of Hintereisferner was successfully simulated throughout the full seasonal cycle. This is based on derivation of the height gradients of the driving glaciometeorological variables along the glacier. Sensitivity studies indicate that the remaining differences between simulated and measured mass balance are mainly due to input uncertainties in the upper reaches of the glacier. This mainly concerns the spatial patterns of albedo and accumulation.